Aerosol Retrieval Algorithm: Updates since Sept. 2014

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(Dec. 4, 2014)

Background

- The combined retrieval algorithm (LP_EDR_NASA) was split into ozone and aerosol components in Dec. 2013.
- More recent changes (Sept. – Oct. 2014) alter how the aerosol retrieval (LP-L2-AER) works.

Mission Statement

- Initially, we seek a simpler algorithm, with easier-to-understand products and residuals
- But we want to avoid a massive, time-consuming code overhaul.
  - All changes were introduced by modifying existing code (not creating new code modules).
  - Resulting new code is archived on the shared TLCF system for common use / testing.
- So the logic of the algorithm is now much simpler, but the code remains unnecessarily complicated (with many disabled functions, etc.) for now…

Description of current algorithm assumptions

1. Turn off the cloud height retrieval algorithm.

Rationale:

• The former algorithm detected a “cloud” when radiance profile slope changed rapidly across the spectrum, and cut off retrieval at “cloud top” altitude

• Some detected “cloud tops” appear to be aerosol layers.

• Future: Use realistic cloud optical properties in a better cloud detection algorithm.

Description of current algorithm assumptions

2. Turn off the aerosol size distribution (ASD) retrieval algorithm.

Rationale:

- Most OMPS LP observations have little ASD sensitivity.

- So just assume a single-mode log-normal ASD when retrieving the aerosol extinction coefficient profiles $\beta_a(\lambda,z)$

Description of current algorithm assumptions

3. Retrieve aerosol extinction at just 1 wavelength.

Rationale:

- The single-wavelength algorithm depends on just one well-characterized wavelength (currently 675 nm, which has been studied for the ozone retrieval).

- Other wavelengths can be tried with this approach (e.g., Ghassan Taha's current work).

Description of current algorithm assumptions

4. Use the assumed ASD + Mie theory to estimate the aerosol extinction at all other wavelengths.

Rationale:

- Using Mie theory provides logical consistency between the assumed aerosol phase function and $\beta_a(\lambda,z)$ for each wavelength.

Description of current algorithm assumptions

5. Turn on the “radiance reconstruction” step.

Rationale:

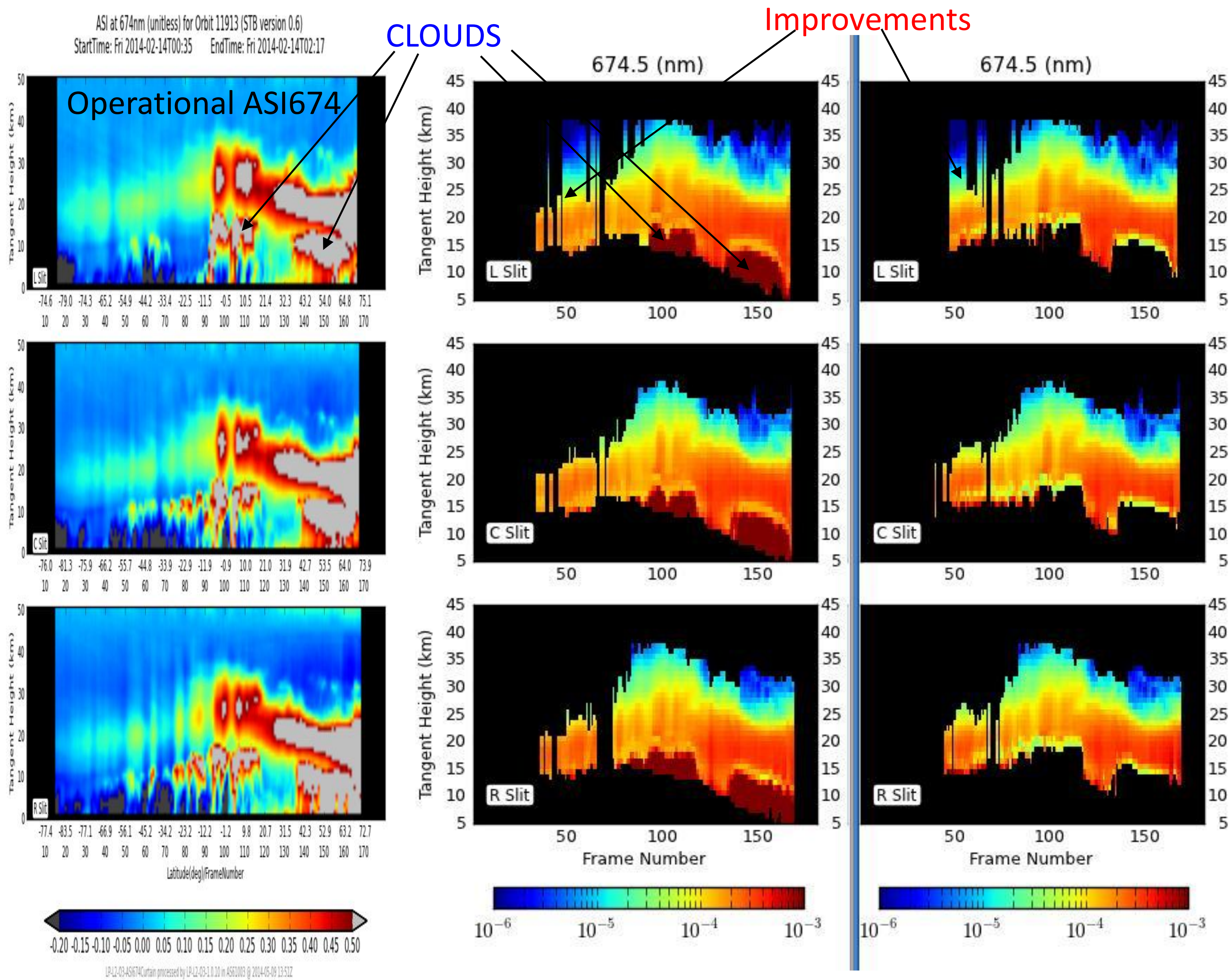
- This final step of the algorithm calculates radiances using the retrieved profiles.

- This creates useful residuals (comparing measurements to model calculations), for quality assessment of the retrievals – see Nick Gorkavyi slide ahead.

ORBIT 11913, Feb 14, 2014

Rob' aerosol extinction

Operational aerosol ext.



Notes on current algorithm performance

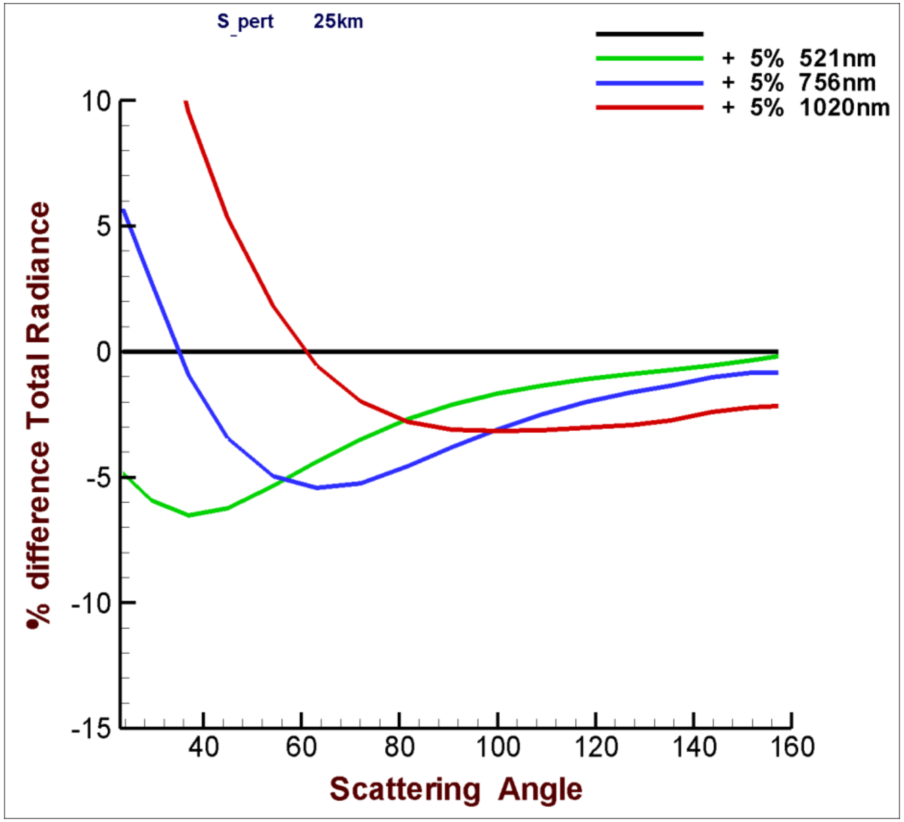
- Current retrieval works deeper into SH.

- Current retrieval works to lower altitudes.

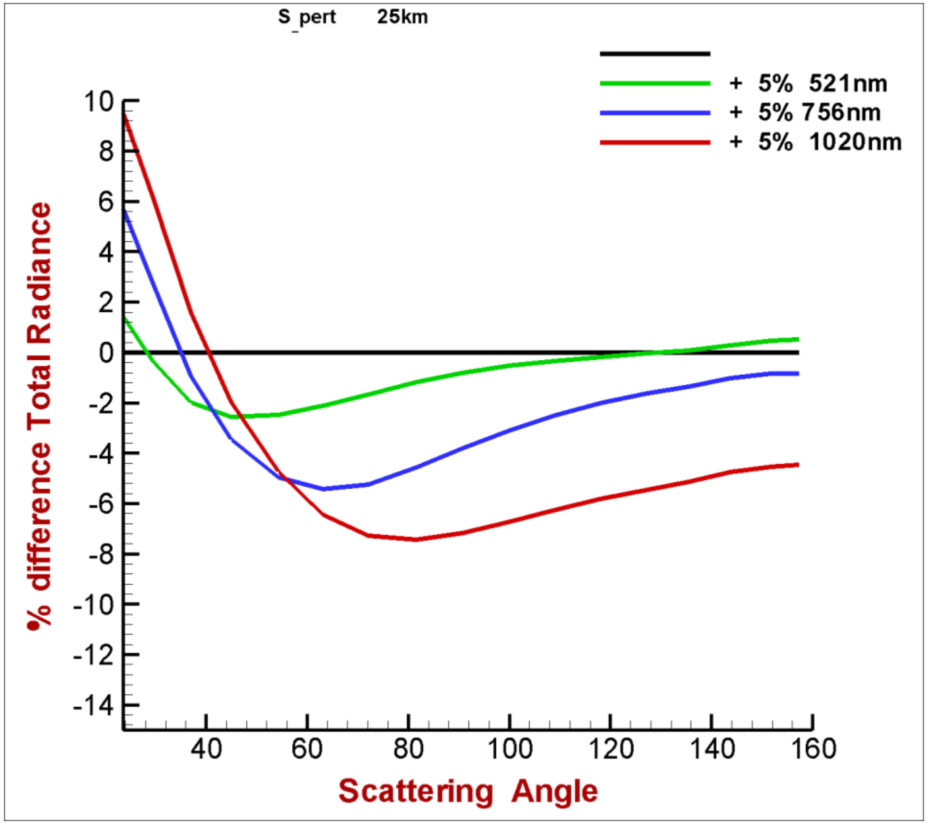
•Current retrieval reduces large ASI / residuals in NH? (TBD…)

Radiance sensitivity to 5% change in ASD mode width (at 25 km)

Fix β_a(756 nm) + use Mie theory



Fix $\beta_a(\lambda)$ at each wavelength



Notes on ASD sensitivity

- When ASD is perturbed, the resulting radiance change has little wavelength sensitivity for most of the orbit:
  - until scattering angle < 70° or so (including 1 μm)
  - until scattering angle < 50° or so (if longest λ is 0.756 μm).
  - Good news: Retrieval of $\beta_a(\lambda,z)$ should usually be fairly robust (tolerating poor ASD knowledge).
  - Bad news: If ASD information is sought, it can only be obtained in NH (& even then, its quality will depend greatly on the λ→1 μm observations).

Future work

- Implement + test better cloud detection algorithm
  - Need to distinguish among cirrus clouds, PSCs, and aerosols for proper interpretation of UT/LS observations.
- Verify improved residuals with new algorithm
- Assist with stray light investigation (if needed)
- Assist with characterization of NIR wavelengths (if needed)
- If necessary, implement a module for ASD information – beging with forward scattering only.

BACKUP SLIDES

Description of algorithm changes

1. Turn off the cloud height retrieval algorithm.

Rationale:

• The former algorithm detected a "cloud" when radiance profile slope changed rapidly across the spectrum

• Retrieval was cut off at "cloud top" altitude

• Some "cloud tops" appeared to be aerosol layers.

• A future cloud detection algorithm will better incorporate cloud optical properties (i.e., large crystals / droplets vs small aerosols).

Description of algorithm changes

2. Turn off the aerosol size distribution (ASD) retrieval algorithm.

Rationale:

- The former algorithm used the wavelength dependence of the aerosol extinction coefficient β_a to update the initial ASD guess.
  - –This ASD update was applied to all observations, even though many have little ASD sensitivity.
  - – The ASD update also neglected the aerosol phase function variation with wavelength.

Description of algorithm changes

2. Turn off the aerosol size distribution (ASD) retrieval algorithm.

Rationale:

- For these reasons, the ASD update did not consistently improve the β_a retrieval (in terms of reducing the radiance residuals), and also made the residuals difficult to interpret.

- A future ASD algorithm appears possible, but will be tried only after more thorough testing of the β_a retrieval.

Description of algorithm changes

3. Retrieve aerosol extinction at just 1 wavelength.

Rationale:

- The former algorithm retrieved β_a at several wavelengths.

- The single-wavelength algorithm is simpler, & depends on just one well-characterized wavelength (currently 675 nm, which has been used in the ozone retrieval).

- Other wavelengths can be studied for consistency with this approach.

Description of algorithm changes

4. Use the assumed ASD + Mie theory to estimate the aerosol extinction at all other wavelengths.

Rationale:

- The former algorithm used an Angstrom coefficient framework to characterize $\beta_a(\lambda)$.
  - The necessary connection between the assumed ASD and $\beta_a(\lambda)$ was lost in this approach.

- Using Mie theory instead provides logical consistency between the assumed aerosol phase function and $\beta_a(\lambda)$, which was lacking in the former approach.

Description of algorithm changes

5. Turn on the “radiance reconstruction” step.

Rationale:

- The former algorithm skipped the final step of calculating radiances using the retrieved profiles, due to run-time concerns.
- Turning it back on allows us to create useful residuals (comparing measurement to model calculations), for quality assessment of the retrievals.